Proposal for
New Innovation Measurement

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Economics and Statistics Administration

in response to

Request for Comments

on

Innovation Measurement

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Introduction

Overview

The real strength of American innovation is its broad base of entrepreneurship and commercialization. There are many big and well-known innovations and companies. But it is the millions of small innovations implemented by millions of Americans in thousands of organizations of all sizes, but especially in small companies, that have added the most total value to the U.S. economy over the past two-hundred years. Information about the innovation activities of many of these companies is under the radar of government agencies.

Innovation is a nebulous concept. Measuring innovation is inherently subjective and imprecise, like measuring creativity or art. Who exactly does the innovating, and why do they do it? What is the value created, how is it realized, and by whom? Exact measures of these activities are hard to identify and collect. But select data on the inputs and outputs of innovation are available and useful for economic analysis.

Productivity is one type of innovation. During the past fifty years, productivity has been the main output of innovation as companies increased production capacity and volume. In simplest terms, more people produced more goods by working faster and using bigger machines.

Many parts of the U.S. economy have changed recently. The speed of business is increasing. The variety of products and services available is increasing. Much of this is due to technological advancements. More diverse and wide-spread innovation has created new types of organizations and activities.

But many of the measures of the economy are still based on the outdated "worker and machine" model. The output of innovation can not simply be turned up, if desired, like the output of a factory, because the inputs and outputs are now "fuzzier" and less controllable.

Innovation is not about ideas or patents. It's about *people* working on new things and in new ways. But existing measures don't explain who the worker is or what they are doing. To understand how innovation influences the economy, new measures are needed at the firm and project level.

The essence of innovation is *individual* work, like writing a song or designing a device, although it is often part of a group effort. Individuals produce more ideas when they work in small groups. Small business is the source of much of the innovation in America.

The source of innovation performance of a national economy is the aggregate behavior of individual firms and the projects on which they are working.

Proposal Approach

Our approach to new and improved measures of innovation is to better measure the root sources of innovation at the firm project level. Then aggregate them up to industry, regional and national levels.

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Increasing innovation is not about simply turning up the speed of a machine – today's innovation might not even have a machine! It's just someone thinking of an idea for a creation or discovery, and then implementing it in some way. In thousands of small and large companies across America.

There needs to be more focus on smaller organizations and smaller innovations. Their aggregate activity and output is a larger component of the U.S. economy than that of big business.

The proposed new and improved measures of innovation are firm-specific. They aim to capture innovation activity at its root in the organizations and projects where it originates.

The proposed measures play on the strengths and advantages of American society and its economy – namely, broad-based entrepreneurship and commercialization.

Assessment of Measuring Innovation in the U.S. Economy

U.S. Economy

According to most recent indicators, the U.S. economy is performing very well. But in the context of innovation, there is some cause for concern.

The prosperity in the U.S. is not uniform. Just three industry sectors (energy, financial services and consumer staples) accounted for 40% of the 2007 Fortune 500 sales and 80% of the increase in profits since 2000. And the technology sector, considered the bastion of American innovation, was the worst performer with an earnings decline of 14% since 2000. Motor vehicles, parts and retailing also lag recently (1).

Much of this good performance can be attributed to rising oil prices, increasing consumer spending, rising values of stocks and real estate, and successfully playing the stock and bond markets – not really showpieces of innovation. Plus, the increase in income and wealth has flowed disproportionately to wealthy Americans.

Real business innovation in America might not be thriving as well as the general economic reports portray.

Measuring Innovation

Many national measures of innovation, such as the System of National Accounts 1993 (2), stem from an era characterized by fewer services and fewer new products. America operated much as an isolated and homogeneous market. Prosperity was based on increasing volumes and lowering costs. Labor and equipment factors drove productivity and prosperity.

Many of these measurements attempt to identify activities or parameters that are correlated with innovation, but are not innovation themselves. For example, patents are simply legal documents, not value-generating ideas. The cause and effect of innovation are not modeled or measured accurately.

If most innovations were patented, then this system would be accurate. But most innovations are not patented. Some innovations have a bigger impact than others, and those few are the ones that are patented.

The current system is outdated and does not distinguish between gains due to production-based productivity and creation-based innovation. It simply sees that value is increasing and it attributes it to the input and output factors used, whether the factors reflect the true nature of the economic activity or not.

If anything, the new economy is the "innovation economy." It is *people* who successfully commercialize new ideas that cause innovation. New ways are needed to measure these causes and effects of innovation.

The relationship between innovation and value created is non-linear. Sometimes relatively simple innovations can have big effects. For example, the minivan or Google. Current measures do not reflect this effect.

It is desirable for business and economic reasons to measure all the elements of innovation, as described in Appendix 1. But such a system would be too complex and the data too difficult to collect and analyze. The proposed new measures measure only the elements of the Innovation Value Index (see Appendix 1) of projects at the firm level.

Trends Affecting the Measurement of Innovation

The following trends affect the measurement of innovation in the U.S. economy:

- New and global markets present more opportunity for new products and services that depend less on labor or volume production.
- Increasing ability to implement new ideas in a broader range of scope and scale. Example: a single desktop computer alone can now be used to capture the global market for a product.
- U.S. economy is shifting from manufacturing goods to providing services.
- U.S. economy is shifting from working harder (more of the same) to working smarter (doing something new).
- U.S. companies are looking for growth in new products and markets as recent cost-cutting programs yield diminishing returns.
- Growth in intangible assets, such as software, goodwill and brand value, muddles financial reports.
- Other countries have upgraded their innovation capacity. Several emerging economies are small but growing rapidly and focusing on high value-added services.

Limitations of Current Innovation Measurement

SNA Does Not Identify Innovation

The System of National Accounts 1993 (2) is useful for measuring productivity in the economy as a whole. But it is very broad-based. Many of its factors are related. It requires advanced statistical analysis to determine clear lines of cause and effect related to innovation.

Many of the factors that capture production-based activities are used to capture creation-based activities. The set of variables is not based on a rigorous model that distinguishes between production and innovation activities.

Other countries that are growing rapidly use SNA to measure their economies. But they may underestimate the true strength of innovation driving their growth. For example, India is growing rapidly but is limited by poor infrastructure. But the economic measures do not reflect the newfound "can do" attitude and spirit of its people toward business that is the root of its growth, regardless of short-comings in infrastructure, capital, R&D, patents, etc.

Using SNA to assess the value of intangible assets is difficult because of inconsistent valuation, foreign domain recording, and international asset transfers.

SNA measures of education levels, such as recent engineering graduates, do not reflect the trend that a growing proportion of these people do not pursue careers in their technical fields. For example, more engineers are working in financial services. Good for the financial services, but the data implies that certain aspects of engineering work are growing when, in fact, they are not.

The SNA often relies on average values, which do not show the complete picture and are often misleading because of the increase in variation of values. The population and economy of America and the world are less homogeneous, especially after the post-war era when many of today's economic indicators were created. Average values do not show diversity, variation or skewness.

Don't Measure "Newness"

Current measures do not differentiate innovative firms from non-innovative firms. The key is to measure the "newness." or novelty of their activities or output.

For example, imitation (copying) is an effective form and strategy of innovation. First Japan, then Malaysia and Taiwan, and now China and India are using it. They have moved or are moving from being a business follower to being a leader by becoming an original innovator. For example, the number of non-U.S. global brands is growing.

But the same core set of measures have been used to describe their economies for the past thirty years. The data explains it by pointing to indicators such as the increase in patents. But that does not reflect the thousands of small businesses that are creating new products and processes to increase output without patents or engineers.

Output per worker might show that some industries are more productive, but it does not show what type of worker is doing it or explain why. For example, the energy sector shows high productivity because it has a high capital-to-employee ratio. But this does not mean high innovation.

Many innovations do not directly impact consumers or end-users. Factors such as "revenue from new products" miss the newness and innovation hidden inside many companies.

Limitations of Measuring Patents and R&D

Patents filed by nationals and foreigners and patent citations are popular measures used to measure (and trumpet!) national innovation. But only a small portion of all innovations are effectively protected by patents.

Although patents are correlated with innovation, they are becoming a less important measure of innovation for the following reasons:

- On average, only 10 percent of patents are commercialized. Of these, only seven of 1000 receive funding. About one of 1000 generate revenue. Thousands of inventions lie dormant in universities, research centers and private companies (3, 4).
- The average value of a patent can be very misleading because the values can vary considerably. In the past, fewer patents per product were filed, so the variation of value was lower. Now, with more patents per product filled and a higher variation there is a weaker correlation between number of patents and revenue (value created). Is it the patent for a new mousetrap or a new Internet search algorithm? The SNA data does not capture it.
- The use of triadic patents (U.S., Europe, Japan) does not reflect the rise of China and India, which have less need to file patents in these jurisdictions than did companies of the past era.
- Bias toward larger companies and more sophisticated products that can justify the expense of getting a patent.
- Some emerging technological areas, such as software and the Internet, do not rely as heavily on patents as, say, pharmaceuticals.

Research and development activity is also a common measure of innovation but is limited because:

- R&D is biased towards larger companies which have formal R&D departments, staff, project management and financial controls.
- Not all R&D expenditures actually go towards the innovation. Some goes to employees or equipment in non-innovation activities such as overhead, production, support or maintenance. Especially true of expenditures for general purpose equipment such as computers and communications.
- "High technology" receives a lot of R&D but it is a moving target. What industries, products and services qualify as "high tech"? The telephone is 100 years old. The personal computer is 25 years old. Dial-up modems are a commodity product. Are they really still high tech?

Measuring Services is Inadequate

Services can be innovative or not, just as can a product. But their design and delivery are more intangible and, therefore, more difficult to measure.

Most service activities are recorded in SNA simply as "revenue." But it does not indicate the nature or innovation of the services or how they are developed.

Framework for Proposed New Measures

Overview and Rational

One way to measure innovation is to measure the activity of firms at the root, namely, projects for creating new products or employing new processes.

The proposed new measures improve the collection and reporting of innovation data in the following ways:

- To differentiate innovative firms from non-innovative firms.
- To differentiate innovation activities (inputs and outputs) from non-innovation activities.
- To identify firm-specific data items related to innovation at the source project level for aggregation and comparison at the industry, regional and national levels.

Some of the proposed new measures are constructed from existing data. Others require new data (survey questions) to be created. The new data are collected in addition to the existing data collected by the survey methods of the respective government departments.

Much of the data collected for the SNA at the firm level is high level, such as "revenue from new products," and does not allow detailed analysis for understanding innovation.

Who is working on the innovations? What is the problem or need? How sophisticated is the solution? At what stage is the project? This information would reveal a lot about the source and nature of the innovations and future activities. For example, knowing the types of employees working on an advanced technology project would relate employment trends to innovation.

The proposed new measures can be used to manage policy and affect competitiveness in the following ways:

- Show the size, type and industry of firms that contribute the most to innovation. Learn from their success and promote investment in similar innovation and commercialization.
- Show the size, type and industry of firms that lag in innovation. Devise assistance programs to increase their innovation activities.
- After some of the proposed new measures become better understood, other countries can be persuaded to collect and analyze comparable data.

Criteria for New Innovation Measurements

The proposed new measures capture some of the elements of innovation (see Appendix 1) not currently measured by existing SNA systems.

Business innovation, as defined in the Request for Comments, is valuable only when it generates commercial revenue and profit. The proposed new measures of innovation are related to commercialization by being:

- Measurable in an objective way, such as countable (number of employees, products, countries, etc.).
- Applicable to most industries, including services.
- Relatively easy for a qualified employees to report on a survey.
- Relatively simple to analyze and interpret for economists, legislators and business managers.

Collecting the data for the new measurements can be accomplished using existing survey channels and programs. A separate innovation program or survey is not required.

Identifying business or technical details about innovations under development requires collecting detailed data about individual projects or products. This is too complex and onerous for the respondents and analysts of the a survey.

The method for collecting data can be apply to small firms, large firms, or all firms, depending on how convenient it is to collect and how useful it is for decision-making. If the survey asks for too much detail, respondents will hide or distort their information. For example, large firms might have too many projects, employees or products to list. Small firms might not have a formal R&D program or project manager. Collection should initially be attempted at all firms in a survey.

Innovation Measurement Objectives and Strategy

The proposed new measures of innovation have the following three objectives and strategies:

Measure Innovation at Entrepreneurial and Small Businesses

The objective is to be more detailed and systematic in measuring projects at small businesses. And to better understand the transition and growth of small business through the business life-cycle.

The strategy is to collect just enough information about project activity to obtain a picture of innovation at small businesses. This strategy focuses on entrepreneurship and business ownership – one of America's greatest strengths and the hope and dream of many of its citizens. This strategy supports the position that "America is open for *entrepreneurs*."

Most U.S.-based small businesses have most of their resources and operations located in America. They spend relatively less on overhead such as administration, compliance and litigation than do large firms. They spend more directly on creating ideas and commercializing them.

In other swords, small business is more innovation intensive. If 10 percent of big business innovation is lost, maybe only 5 percent of true innovation is lost. But if 10 percent of small business is lost, maybe 9 percent of true innovation is lost. So, America stand to lose more innovation if entrepreneurship suffers than if big business suffers. Remember, most big companies started as small companies.

Small business faces far more challenges for growing successfully in the global economy. They need more help. Knowing more about them would enable the government to help them in better ways, such as education and lowering barriers to entrepreneurship and commercialization.

Measure Innovation at the Project Level

The objective of the proposed new measures is to identify and describe the projects on which firms are working. This will reveal some of the new products, services, processes, and models being created in America. It will help to link actual innovation work with the creation of value and wealth.

Commercializing innovative ideas is managed through business projects. The proposed new measures will help policy-makers and business people by:

- Making the relationship between business input and output at the project level less mystic and more structured.
- Making more people aware of factors that make innovation projects succeed or fail.
- Enabling more people and businesses to overcome obstacles for starting, organizing and managing a business and any innovation projects.
- Integrating with existing programs or suggesting new programs at the Small Business Administration.

Some information will be proprietary or withheld for competitive reasons. Some projects will be terminated or end in failure. The purpose is to get a general picture of innovation projects for comparison and trend purposes.

Measure the People Who do the Innovating

People create ideas, operate businesses and commercialize new products. The proposed new measures link the business and projects with the people doing the innovating. They will help policy-makers by:

- Identifying the type of employee working on innovation projects.
- Identifying the size and location of project teams.
- Identifying the number of external partners working on a project.

Impact of the New Innovation Measurements

The proposed new measures will impact the department in the following ways:

- Coordinate procedures and data with Bureau of Labor and Statistics, Bureau of Economic Analysis, Small Business Administration and other government agencies.
- Coordinate procedures and data with industry groups and associations for promoting responses and avoiding duplication of surveys.
- Revise printed survey forms.
- Design and develop Web-based forms.
- Design and develop software to aggregate data from printed forms and Web-based forms.
- Reduce costs because Web-based forms are less costly and time-consuming to manage than are paper-based forms.
- Results available immediately and easily for analysis.
- Train department analysts to analyze, interpret and present new data.

Data Collection

The SNA currently collects information mostly by paper-based survey, although Web-based methods are being used more.

The proposed new measures require more detailed information to be collected. The respondent needs to be at a senior project manager level or greater to be able to provide the details for the new measures.

This can be implemented more efficiently for the government and respondents by developing an Internet-based survey system with the following features and procedures:

- Present dynamic forms (pull-down list boxes, etc.) to respondents.
- Respondent creates a profile.
- Respondent update their profile as necessary. More convenient for larger forms that have more complex operations. Saves time for submitting incrementally different information.
- The form and system is effectively a living survey response.
- Anonymous response, if necessary.
- Secure and confidential, as technology available.
- The selection lists for the survey responses for the new measures are intentionally limited. This keeps the scale of responses more manageable. If a broader selection list would provide more meaningful information, the lists can easily be expanded.
- Some of the selection lists have fine gradations at the lower scale. This is to be more useful for small firms and to capture smaller differences in work projects at small firms.

Examples of Use of the Proposed New Measurements

The following examples illustrate the use, application and reporting of the proposed new innovation measurements:

- 15 percent of firms established in the past three years have introduced five or more new products into export markets during the past year. These products generated $125 million in revenue. This compares with 12 percent of firms and $100 million, respectively, a year ago.
- The size of team working on innovation projects is five persons. The size of team working on non-innovation projects is seven persons. These values have not changed over the past year.

- The consumer products sector leads the economy in creating economic value from innovation work at $500 million. The financial services sector is second at $400 million.
- The average size of the business problems that small-medium-sized innovative firms are working on is $5M. Large-sized innovative firms are working on problems of $50M.
- 20 percent of small firms and 10 percent of large firms are working on breakthrough innovation projects.
- A recent resurgence of innovation work by medium and large firms in the physical sciences has prompted several local governments to increase funding for education and training in energy management.
- A six-month surge in project work in the financial services industry in New York employing specialists supports the claim by industry that the city is maintaining its status as the leading base for financial services in the world.
- Although sales of innovative U.S.-made software over the past year are growing in Asia, most of the growth is by medium-sized firms selling consumer software. Sales of innovative industrial software in Asia by large firms are flat.
- Small-sized producers of wood products are experiencing longer periods of product development compared with two years ago. This reflects the increasing complexity and value-added content of their products.
- 35 percent of small-medium-sized firms report increased logistics as a barrier to achieving success in their sales of new products in Asia. This compares with 30 percent one year ago.

Proposal for Firm-specific Data Items

The following proposed data items measure aspects of innovation at the firm and work project levels. They are based on the inputs and outputs of innovation activity as described in the Innovation Value Index (see Appendix 1).

Respondents will complete the form **for each project** on which they are currently working (allocating resources) or for which they are responsible.

Output: Problem

These parameters measure the problem which firms are planning to solve or are actually solving with their project solution. They are an output of innovation.

Parameter	Description	Range of Response (Selection List)
Size of the problem: People	Number of people who could buy or use the solution.	10E2, 10E4, 10E6, 10E8, 10E10
Size of the problem: Organizations	Number of organization who could buy or use the solution.	10E1, 10E2, 10E3, 10E4, 10E5
Size of the problem: Dollars	Amount in dollars of market sales for the solution.	10E6, 10E7, 10E8, 10E9, 10E10
Priority of Need: Importance	Importance of need to buyer/user	Low, High
Priority of Need: Urgency	Urgency of need to buyer/user	Low, High

Notation example: 10E6 would be displayed on the survey form as “One Million”.

Output: Solution

These parameters measure the solution (project, product, model) which firms are planning to design or are actually designing. They are an output of innovation.

Parameter	Description	Range of Response (Selection List)
Novelty of Solution	Degree of novelty of the solution.	Not Novel (Existing) Incremental (Sustaining) Differential (Expanding) Breakthrough (Disruptive)
Technologies employed	Type of technology used in the solution	Information & Communications Life sciences Basic Physical sciences Advanced Physical sciences Environmental sciences Mathematics Psychology Social sciences Business organization/model
Advancement of Technologies	Level of advancement of technologies used in the solution	Low (simple) Medium (standard) High (leading)
Source of Technologies	Source of technologies used in the solution	Internal, External

Output: Implementation

These parameters measure the implementation (result of the deployment of resources) of the project solution. They are an output of innovation.

Parameter	Description	Range of Response (Selection List)
Number of patents	Number of patents received for this project. Could also be triadic patents.	Select from list of numbers
Number of industrial designs	Number of industrial designs received for this project	Select from list of numbers
Number of trademarks	Number of trademarks received for this project	Select from list of numbers
Sales Market Scope	Actual sales per country for this project (product)	Multiple selection of countries and amounts
Success Factors	What factors contributed to the success of this project	Multiple selection from list
Barriers to Success	What factors inhibited the success of this project	Multiple selection from list

Inputs

These parameters measure the inputs of capital, labor and time a firm uses for designing and implementing their project solution.

Parameter	Description	Range of Response (Selection List)
Size of team: Managers	Number of full-time-equivalent	1, 2, 3-4, 5-9, 10-19, 20-49,

	employees working on the solution. Could use hours of work.	50-99, 100-249, 250-499, 500-999, 1000-1999
Size of team: Specialists	Number of full-time-equivalent employee subject-matter Specialists working on the solution.	Select from list of numbers
Size of team: Assemblers	Number of full-time-equivalent employees constructing or assembling the solution.	Select from list of numbers
Size of team: Administration	Number of full-time-equivalent people working on administration duties for the project	Select from list of numbers
Location of team members: At main location or in same city	Number of employed team members	Select from list of numbers
Location of team members: in same country	Number of employed team members	Select from list of numbers
Location of team members: in another country	Number of employed team members	Select from list of numbers
Number of Partners	Number of external partner groups or parties involved with this project	Select from list of numbers
Capital	Sources and amounts of funding for this project	Internal funding Commercial lender Venture capital (private) Public capital Government
Project Status	Status of project. Date of initialization.	Concept Research Development Production Commercial sales

Analysis of Survey Data

In addition to standard data reports, analysis of the data and meta-data of the responses will provide:

- Correlation of existing SNA survey data with the new innovation measures.
- The number of projects on which firms are working now.
- Number, status and type of project (product) for each export country.
- Flow of projects through the life-cycle stages of research, development, production and commercial sales.
- The stage and duration (length of time) of projects.

Appendix 1: Elements of Innovation

Innovation has become a business cliché and mantra. A goal in itself. There is a lot of misinformation and myth, even from reputable sources. This section describes a framework of the elements of business innovation.

The elements are separate and mutually exclusive. They can be used to characterize innovation of all types of industries, organizations and project and products. Consider all of the elements to get a complete picture of an innovation or how to innovate.

Definition of Innovation

There are three broad categories of innovation:

- Artistic – such as painting, dance, humor.
- Business – such as money, computers, barter, public stock ownership.
- Social – such as democratic government, private property, religion, public education.

Some innovations can be categorized in more than one category.

We define business innovation as follows:

Introducing something new (product, process or business model) to a market or within an organization.

We also generally agree with the definition of business innovation as described in the Request for Comments, which defines innovation as:

The design, invention, development and/or implementation of new or altered products, services, processes, systems, organizational structures, or business models for the purpose of creating new value for customers and financial returns for the firm.

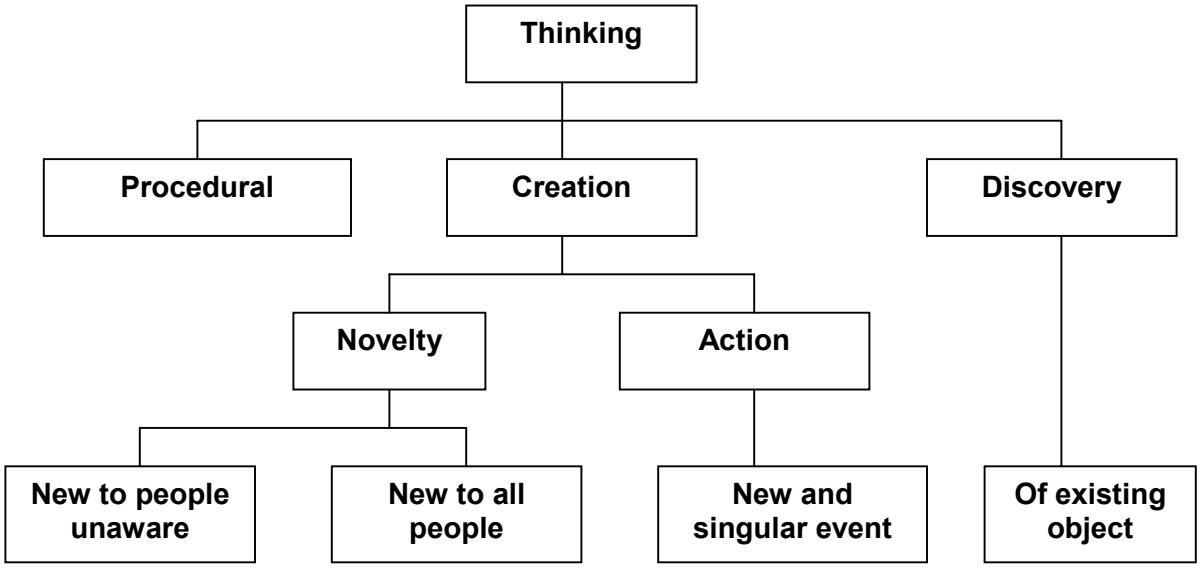
Types of Business Innovation

There are five types of business innovation:

Type of Business Innovation	Description	Example
Product	Physical object	Computer hardware
Service	Delivers value in an intangible way	Public singing
Process	Procedure to accomplish a task	Tempering glass
Business model	Of generating revenues and incurring expenses	Recurring revenue
Organizational structure	Of business resources and activities.	Virtual team

Innovation Schema: Creation and Discovery

The two main types of thinking that create innovative results are creation and discovery. The purpose of the following schema is to show the relationship of creation and discovery and show the two types of creation.



Thinking – Using intelligence to recognize a pattern that can be stored for later recall. Example: Standing on a cliff is dangerous.

Procedural – Use a formula or follow a procedure. Example: If standing at cliff edge, step back.

Creation – Creating something that did not exist before.

Novelty – Creating a new thing or way to do something. Example: Invent a new device.

Action – The act of bringing something new into existence. Example: Create music by singing a song. If the song is sung the same way a second time, then it is a procedural act and not creation. Art can be a novelty, action or both, depending on whether it existed before.

Discovery – To find natural resources, natural phenomena, or other's innovation for the first time. The same item can be discovered by more than one person and more than one time. Example: Planet Saturn, double-helix DNA, Starbucks coffee, loose tooth.

Degree of Novelty of Innovation

The degree of novelty of an innovation ranges from incremental to breakthrough. Incremental innovations are smaller, easier to implement and less risky. They are good for sustaining your business. Breakthrough innovations are more radical, more complicated and more risky. They can disrupt the market in a big way and provide a big leap in growth.

Most companies succeed over the long-term by making a continuous series of incremental innovations focused on growth and developed across many areas. But some organizations are too risk-averse and resist all change to the point where they stifle all innovation and growth. To achieve sustained growth, companies should pursue a range of degrees of novelty.

Levels of Degree of Novelty of Innovation

Type of Innovation	Share of Resources	Degree of Novelty	Competitive Move	Innovation Scope	Complexity (Risk)	Time Frame	No. of Projects
Breakthrough	10%	High	Disruptive	New products, processes and markets. Business model.	High	Long-term (months-years)	Few
Differential	20%	Medium	Expanding	New products, processes or markets.	Medium	Mid-term (weeks-months)	Several
Incremental	70%	Low	Sustaining	Existing products. Core processes	Low	Short-term (days-weeks)	Many

Notes:

- "Resources" are the expenditures and labor for research and product development.
- All three types of innovation should support the corporate objectives and strategies.
- Innovation pyramid model applies to firms of all sizes and to all industry sectors.
- A firm's innovation pipeline (product portfolio) should have a 70-20-10 ratio. Rebalance resources as the portfolio changes.

Source: Spectrum Innovation Group

Scope of Innovation

The scope of innovation shows the breadth in which existing or new technology (product, process, model) is used by the firm or sold to the market for the first time. There are eight situations.

Market Scope	Existing Technology	New Technology
New to the firm (for internal use)	1	2
New to the buyer/user (no previous use here)	3	4
New to the Local, regional or national Market (no previous use here)	5	6
New to the world (no previous use anywhere)	7	8

Value of Innovation

Innovation creates truly new and original products or activities. It is not the recreation or duplication of a product or activity or the pooling or redistribution of wealth. What is the true value created? In many cases, such as art, the value of innovation is in the "eye of the beholder" although the objective here is to quantify innovation in economic terms.

The overall value of innovation is measured by the positive and negative effects or results it has on commerce and society for the inputs consumed.

What is the net value created by an innovation? The output effects range from positive to negative. Positive effects help people and improve society. Negative or harmful innovations cause problems and expenses for people and organizations. Judgement of the effects depends on the situation and who makes the judgment. Each individual in each local region decides on value to themselves.

The overall value is the sum of the value to everyone effected in all places. The value can be measured in financial dollars (profit or loss), number of objects (created or destroyed), or the happiness or hardship of persons affected.

The following list of effects of innovation is illustrative and by no means complete.

Innovation	Effects	Example: Products	Example: Services
	Strong positive effects		
Medical advances	Live healthier and longer	Heart pacemaker	Physiotherapy
Education and training	New knowledge and skills	Television, DVD	Teaching, broadcasting
Customer benefits and satisfaction	Convenience, enjoyment, well-being	Phone, BBQ, roller coaster,	Estate planning
Entertainment	Enjoyment, reduce stress	Video game	Professional sports
Industrial productivity	Higher outputs or lower inputs	Improved industrial lubricants	Real-time equipment monitoring
Personal productivity	Higher outputs or lower inputs	Personal computers	Internet search
Creation of downstream innovation and value	Input for further activities	Telephone	Google search
Damage or destruction of property	Financial loss	Defective designs. Malicious software.	Toxic building materials
Injury or death to animals or livestock	Pain and suffering	Pesticides	Destruction of habitat
Injury or death to humans	Pain and suffering	Guns, toxic drugs	Reduce motor vehicle safety laws
	Strong negative effects		

Innovation Value Index

The above factors can be grouped into a high-level model of inputs and outputs called the Innovation Value Index.

The root of an innovation is a person who has an idea to solve a problem. A project is planned to develop a solution in the form of a product, service, process, business model, or organizational model. The solution is commercialized by implementing the project plan.

The parameter values can be normalized. The result is an index of the relative value of the innovation. For example, if a project has a great solution to a big problem but takes ten years to complete, it has a lower value than a similar project that can be completed in five years.

$$\textbf{Innovation Value} = \frac{\textbf{Outputs}}{\textbf{Inputs}} = \frac{\textbf{Problem x Solution x Implementation}}{\textbf{Capital x Labor x Time}}$$

Where:

Problem = **Problem Size** (people, organizations, dollars) **x Need Priority** (Importance, urgency)

Solution = **Novelty x Sophistication** (technology, type, advancement source, quality)

Implementation = **Intellectual Property** (patents, industrial designs, trademarks) **x Sales Market Scope** (export countries) x **Success Factors** (and barriers)

Capital (sources, amounts)

Labor = **Team** (members, type, location) **x Partners**

Time (project status and duration)

An intangible factor that affects the solution and implementation of innovation is the element of chance (luck), such as accident, being at the right place at the right time, or the timing of events. Luck is often a key factor for success in business. It is virtually impossible to measure.

The Innovation Value Index is different from productivity and efficiency measures because it focuses on a specific project for a new or improved product. Productivity and efficiency apply to ongoing activities, although innovative improvements often increase productivity. The outputs can be used for end-user consumption (consumer) or as inputs for other commercial projects (business).

Appendix 2: Drivers of Innovation

The value of innovation is higher if it maximizes the outputs and minimizes the inputs of innovation (see Appendix 1). Capital and infrastructure are not included because they support, but do not drive, innovation. Business innovation starts with people who commercialize solutions that consumers or users want. Capital and infrastructure enable them to implement their plans.

Sophistication of Customers (Markets)

The sophistication of customer demand for new products and services varies in each market. It is not just the sophistication of demand, but also the variation of demand across high-end and low-end products that drives innovation and spurs development of all types of products and services.

Work Force

Innovation is done by people. Innovation requires knowledgeable, creative, and energetic people. They must have practical and critical thinking skills, curiosity, and a mind that can grasp complexity and work with it. The following work force factors drive innovation:

- Skills for creativity and discovery. Open to new things, skills and ways.
- Skills for implementing and commercializing innovative concepts.
- Propensity for risk. Match people with projects.
- Ability and readiness for hard work. Persistence to overcome obstacles.
- Motivation for pursuing innovation and entrepreneurship.
- Career stage. Are employees aspiring to change the world, push paper, or retire?
- Age of employees or business people. In general, innovation is a young person's game.

Technology

Technology has always had a major influence on innovation. Some of the biggest innovations of all time are based on new technology. Technology drives innovation in the following ways:

- New tools (devices and processes) for internal invention, production and productivity.
- New products and services for external consumption or integration.
- Life cycle – Most technology is eventually superceded and made obsolete. As it matures, it has diminishing returns and value to the user.

Organizational Structure

The structure of the organization affects innovation output in the following ways:

- Organization – The organization of departments, teams and partners affects communications, collaboration and decision-making.
- Team – Number and diversity of partners and team members. Smaller teams focus more on results and spend less time on wasteful and unproductive activities.

Complexity of project reporting – Deep project reporting matrices often leave managers disconnected from the real work and projects end in disarray. Flat reporting increases speed of development and decision-making but can lead to overload and mistakes.

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